

LOGANEnergy Corp.
Final Technical Report
Climate Change Fuel Cell Grant
DAAE30-97-1-0116, Modification P00004

Merck & Company PC25C Fuel Cell Installation, Rahway, NJ

Abstract

Merck & Company is a leading research-driven pharmaceutical products and services company. Merck discovers, develops, manufactures and markets a broad range of innovative products to improve human and animal health. In October 2001, Merck approached LOGAN to assist in the installation and commissioning of one UTC PC25C fuel cell power plant. LOGAN agreed to do so, and contributed one of its FY1997 DOD Climate Change Fuel Cell (CCFC) grants to the project. Subsequently, in June 2002, LOGAN installed one UTC PC25C fuel cell at Merck's Rahway, NJ pharmaceutical plant. Commissioning occurred on 7 June 2002, and LOGAN submitted the final financial summary report in mid July.

This purpose of this report is to conclude the CCFC grant process for the Merck site by submitting the final technical report, as required under the terms of the grant. Therefore this document summarizes the major operating highlights of the fuel cell project since it's commissioning, and provides further data on the fuel cell's current status.

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Executive Summary

In February 2002, Merck & Co., finalized the purchase of one United Technologies Company (UTC) PC25C Fuel Cell Power Plant, S/N #9250 with the assistance of one DoD Climate Change Fuel Cell Grant, previously awarded to LOGANEnergy, grantee. UTC delivered the unit to the site in March 2002. The fuel cell had the following configurations (a) to operate on natural gas (b) to deliver 800,000 Btu/h waste heat through a customer interface heat exchanger; and (c) to provide both grid connected and/or grid independent electrical service. The installation/construction began on 15 March 2002, and concluded on 1 June 2002. By 7 June 2002 LOGAN completed the commissioning/initial start-up and reported to DOD that the unit had completed a successful eight-hour acceptance test. Figure 9, below, illustrates the site layout plan.

The unit has operated continuously since initial start-up with two brief interruptions due to balance of plant service issues. In that time, LOGAN has performed one quarterly inspection, and performed one additional service call to readjust FCV110, the fuel control valve, which shut the unit down for two days. This report together with the Merck Financial Status Report, previously submitted to DOD, constitutes the final submittals required by grantor to satisfy the terms and conditions of the grant number DAAE30-97-1-0116, Modification P00004.

1. Introduction

Figure 1, below is a photo of the personnel involved in the UTC PC25C fuel cell power plant SN 9250 project that was installed by Merck & Company at its Rahway, NJ plant. The power plant, shown in the background, has



both grid parallel and grid independent configurations, however only the grid parallel feature is currently in service. The installation includes low-grade thermal recovery interface with the facility and provides up to 800,000 Btu/h to the pharmaceutical plant.

Figure 1

2. Results and Discussion:

06/07/02...Merck's PC25C fuel cell power plant was started for the first time. It was set to deliver 200kW in a grid connect configuration.

Figure 2 at right is a block diagram of the system operating components in the Merck PC25C fuel cell power plant. Figure 3 below, shows S/N #9250 cell stack voltage measurements within a month of initial start-up, indicating acceptable performance.

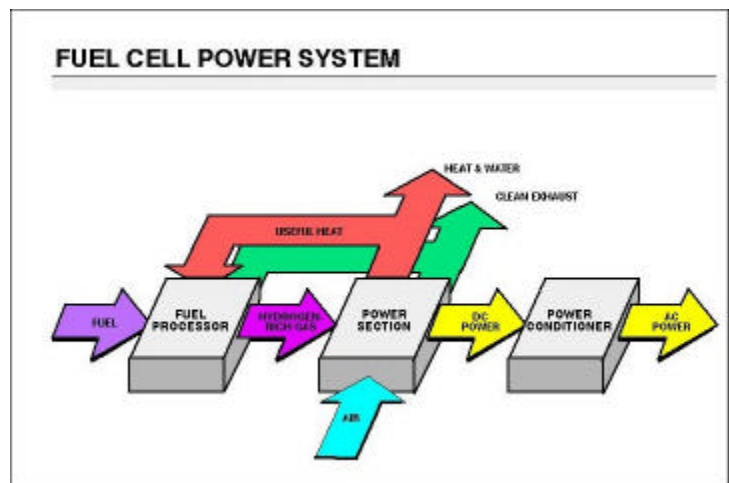
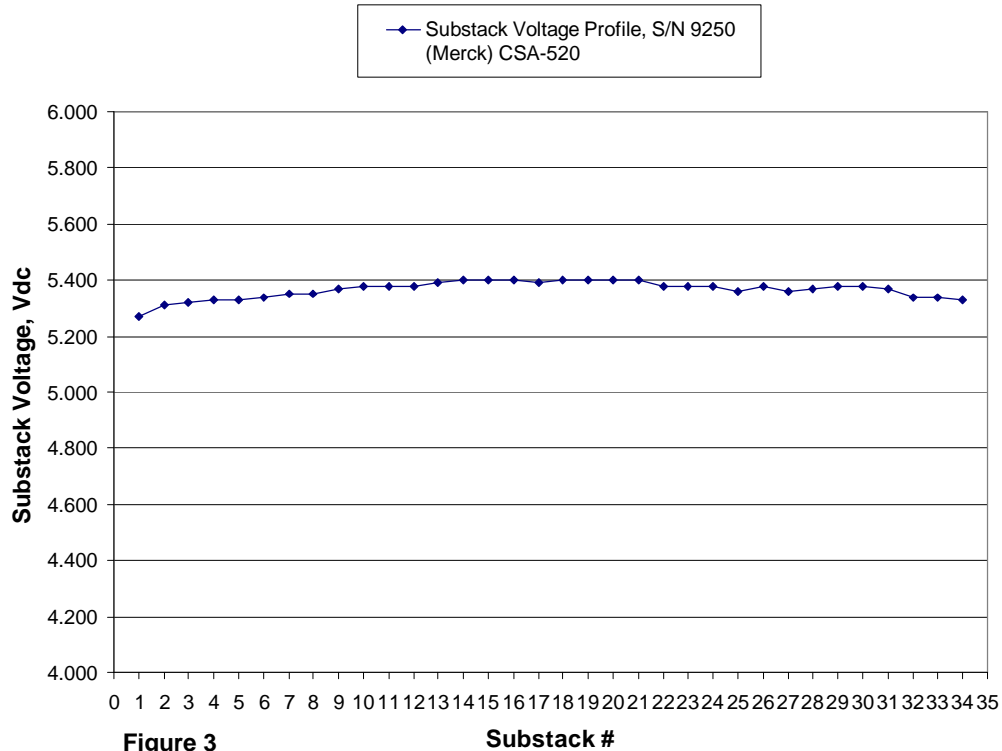


Figure 2

06/28/02...The unit shut down because of a control cable failure. Merck personnel changed the controller IO input cable and restarted unit.

07/11/02...LOGAN returned to the site following a shut down. The FCV110 fuel control valve was found to be malfunctioning and was repaired. The unit was also programmed with a controller software upgrade (5.4) to improve operating reliability.



11/20/02...LOGAN performed the power plant's first quarterly service checks, and replaced 4 HEX 800 fan motors with new high temperature motors. Unit operating well since then.

3. Mean Time Between Forced Outages (MTBFO)

During the period June 7 through January 31, 2003, S/N 9250 accumulated approximately 4601 load hours. During that period this unit has experienced two forced outages. The first was occasioned by the failure of a ribbon connector in the Electronic Control System (ECS), the second due to a failure of the logic card in FCV110 fuel control valve.

4. Reliability

Judging by the operational reliability of a large number of PC25 units that LOGAN supports throughout the US, S/N 9250 exceeds the historical reliability norm for installations of this type. This is because Merck has provided strong leadership to operate and maintain the fuel cell in a professional and thoughtful manner. In addition, the fuel cell plays well to Merck's corporate image as a technology leader, and it is a visible reminder of that to its customers, stock holders, and the local community. The fuel cell installation occurred without any major problems or delay, and the commissioning and start-up of the unit was normal in all respects.

5. Thermal Output

The fuel cell supplies waste heat in support of the domestic hot water requirements of the Merck plant. 140 degree F. hot water circulates between the fuel cell HEX880 and a secondary heat exchanger in the plant, reducing the need for natural gas to fire the boiler. The system capacity is 800,000Btu/h.

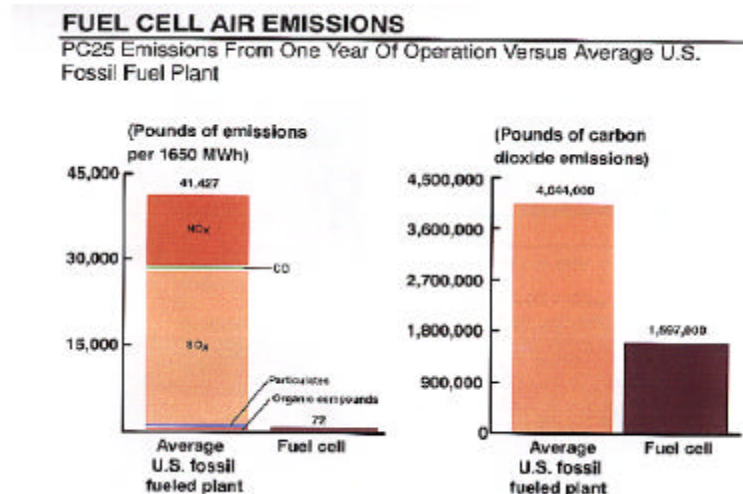
6. Environmental Benefits

The environmental benefits of fuel cell power generation, Figure 4 at right, have been certified by several independent state and federal agencies; most notably the South Coast Air Quality

Management District in California.

Figure 4

In that regard, the PC25 has an enviable record. One unit operating at 200kW for one year occludes in excess of 40,000 pounds of harmful emissions as compared to an equivalent number of megawatt hours normally associated with oil or coal fired power generation.



7. Cost Benefit Analysis

Simple Project Cost Benefit Analysis June 15 through Jan. 31, 2003			
Installation Cost	\$1,303,308		
Total Load Hours	4601		
		<u>Cost</u>	<u>kWh</u>
Total kWh produced during report period			920,200
Estimated MCF NG	9,202		
Ave. Cost per MCF	\$6.50		
Cost NG		\$59,813	
Cost of Service/Materials		\$3,800	
Total operating cost		\$63,613	
Cost per Fuel Cell kWh	\$0.069	\$63,613	
Cost displaced electricity	\$0.085	\$78,217	
Thermal Recovery MCF	1150.25	\$6,500	\$7,477
Benefit	\$0.016		
Annual Savings		\$22,081	

Figure 5, Cost/Benefit Analysis

8. Current Status of S/N 9250 as Viewed on Controller Screens of 11/16/02

A. Power Plant Electrical Screen			
T Screen #: 014 Page #: 00 ScrFileID#: 7E83 ESC or Q = Quit			
ELECTRICAL			
11/16/02	IDC=1311	VDC= 180.1	KWACNET=200.1 IDCNORM= 1393.0 EVENTS: 1
1507:57	TE400FT= 359	TE012FT= 1564	VT310DEL= 0.22 OVERRIDES: 0
P/P 9250	P 150	R 160	S 60 W 20 A 30 N 40 C 30 L 10 I 50
LOADTIME	TOTAL LOAD TIME	3214 HR	TOTAL HOT TIME 3322
MWHRNET	NET AC MW HOURS	36.5	MWHR
PWRLIM	LOADSHARE POWER LIMIT	1.0	KW
KWACNET	NET AC POWER	200	KWAC
PFACT	ACTUAL POWER FACTOR	0.85	
KVARNET	NET KVAR	124	KVAR
CM001	INSTANTANEOUS AMPS	1311	AMPS
KWDC	DC KILOWATTS	236	KWDC
VT310A	TOPHALF STACK VOLTAGE	89.7	V
VT310B	BOTHALF STACK VOLTAGE	89.9	V
VT310	DELTA HALF STACK VOLTS	0.22	V
VDCTOT	TOTAL STACK VOLTAGE	179.6	V
VDCNORM	NORMALIZED VDCTOT	169.0	V
MCB001	G/C BREAKER STATUS	CLOSED	
MCB002	G/I BREAKER STATUS	CLOSED	
FBDUR	F/B OR B/O DURATION	0	SEC
CT001-A	NET AMPS A	281.9	
CT001-B	NET AMPS B	284.7	
CT001-C	NET AMPS C	278.7	
PT001-A	INV VOLT A-B	482.6	
PT001-B	INV VOLT B-C	480.3	
PT001-C	INV VOLT C-A	484.3	
PT003-A	GRID VOLT A-B	482.7	
PT003-B	GRID VOLT B-C	479.6	
PT003-C	GRID VOLT C-A	483.3	
1Helpb 2Send 3ClrOvr 4ClrAll 5LstScr 6Oper 7Event8Scr_10 9Scr_11 10Elec			

Figure 6 *** Note cumulative load time in bold blue as of 11/16/02.

B. Stack Loop, Ancillary Loop & Water Treatment Screen

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T Screen #: 011 Page #: 00 ScrFileID#: 943D      ESC or Q = Quit
                STACK LOOP, ANC LOOP, & WTS
11/16/02  IDC= 1310 VDC=180.2 KWACNET=199.9 IDCNORM= 1391.9 EVENTS:   1
1507:45 TE400FT=  359 TE012FT= 1561 VT310DEL= 0.22  OVERRIDES:      0
P/P 9250  P 150  R 160  S  60  W  20  A  30  N  40  C  30  L  10  I  50

TE400 SEPARATOR TEMP(PRIMARY)  359  DEGF  SETPOINT: 352
TE400R SEPARATOR TEMP(BACKUP)  359  DEGF  SEP TEMP FACTOR (DEGF)  1.000
TE400DEL SEP TEMP DELTA         1  DEGF  STK FLOW SW (FS400)      ON
TE401 COOLANT INLET TEMP      287  DEGF  SETPOINT: 280
TE431 POLISHER TEMP           87  DEGF  F/W TEMP SW (TS451)      ON
TE820 CONDENSOR EXIT TEMP     192  DEGF  TE820 CONT. ERR (DEGF)   4
VSD830 PMP830 SPEED           49  %    VDCNORM (VOLTS)         16 9.2
CE450 CONDUCTIVITY            NORMAL STEAM MODE : DISABLED (OPT.)
LT400 SEPERATOR LEVEL         8.7  IN   PT350  0.0 IWC AIPFB  0 KW
LT450 WATER TANK LEVEL       41.9  IN   WTSFB 0.0
TE464 ILS COOLANT TEMP (OPT)0  DEGF  SETPOINT: 0
PMP451 WTS FEED WATER PUMP ON  PUMP ON TIME (MIN) 2
STARTTEMP TEMP FOR REF HEATUP 315 DEGF  NCELLFACT 1.063
IDCNET NET DC CURRENT 1310 AMPS LT450FT (IN) 41.9
HTR400 ELEMENT 'A' OFF ELEMENT 'C' OFF
      ELEMENT 'B' OFF ELEMENT 'D' OFF

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Figure 7

The power plant controller screen in Figure 7, above, indicates that the thermal management system is adjusting to match the operating set point. Note that TE400 cell stack temperature of 359(blue bold above), while the set point is at 352 degrees F.

C. Reactant, Ancillary Coolant, Nitrogen and Cabinet Vent Systems

T Screen #: 010 Page #: 00 ScrFileID#: 9CDA ESC or Q = Quit
 RSS/APS/NPS/CVS
 11/16/02 IDC= 1306 VDC=180.0 KWACNET= 200.2 IDCNORM= 1387.4 EVENTS: 1
 1504:13 TE400FT= 360 TE012FT= 1561 VT310DEL= 0.22 OVERRIDES: 0
 P/P 9250 P 150 R 160 S 60 W 20 A 30 N 40 C 30 L 10 I 50

TE012 REF TUBE TEMP (PRIMARY)	1561	DEGF	SETPOINT:	1567
TE012R REF TUBE TEMP (BACKUP)	1566	DEGF	TEMPFACT:	0.98
TE012 DEL REF TUBE TEMP DELTA	4	DEGF	CONT MAX/MIN LIM	1.24 /0.85
FT012ACT ACTUAL FUEL FLOW	80.4	PPH	SETPOINT:	82.9 PPH
ZT010 ECTOR POSITION	62.0	%	SETPOINT:	62.1
PHIMON I MONITOR	1.03		FUELTOT (SCF)	5662858
TE350 ANODE INLET TEMP	394	DEGF	PT350/FB (OPT)	0.0 0.0
TE002 HDS BED TEMP	550	DEGF	HTR002 STATUS:	ON
TE001 PRE-OX BED TEMP(OPT)	548	DEGF	FCV012 (FUEL VALVE)	76.3
TE010 HDS INLET TEMP(OPT)	548	DEGF	FT012ERR	-3.1
FT140 BURNER AIR FLOW	561.3	PPH	SETPOINT:	565.2 PPH
ZT110 CATHODE AIR VALVE POS	50.3	%	SETPOINT:	50.2
PT012 FUEL VALVE EXIT PRESS	7.59	PSIA	TE011 (FUEL, DEGF)	50
TE150B MOTOR COMP EXIT TEMP	77	DEGF	TE150A (AMB.,F)	46
FAN150 MOTOR COMP FAN	ON		MOTOR COMP FS150	ON
FAN165 FUEL COMP FAN	ON		FUEL COMP FS165	ON
CV720 FUEL SIDE N2 VALVE CLOSED			ANODCONF (LBS)	0.0
CV710 AIR SIDE N2 VALVE	CLOSED		AT201 (ADG ONLY)	
0.0				

1Helpb 2Send 3ClrOvr 4ClrAll 5LstScr 6Oper 7Event 8Scr_10 9Scr_11 10Elec
Figure 8 * Note total natural gas consumption in SCF bold blue font.**

**Merck & Co Fuel Cell Installation
Site Plan at Rahway, NJ Plant
Grid Connected with Thermal Recovery**

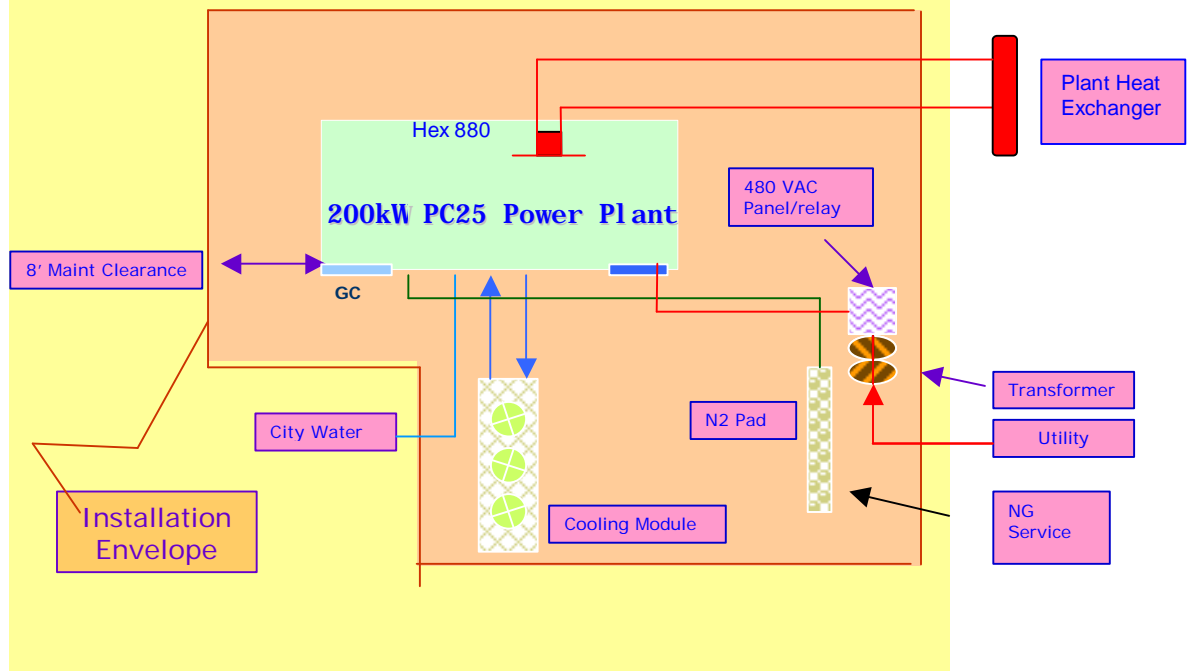


Figure 9, Installation Site Plan

9. Conclusions

Merck & Company has successfully adopted fuel cell technology at its Rahway plant with a UTC PC25C fuel cell in a very practical CHP application. The project should continue to show good results because Merck has dedicated the resources to operate and maintain their power plant safely, professionally, and efficiently.

10. Certification

LOGANEnergy Corporation certifies that to the best of its knowledge Merck & Company has completed all of its obligations under Climate Change Fuel Cell Grant DAAE30-97-1-0116, Modification P00004, and attests to the sufficiency of those activities in meeting all grant obligations



Figure 10

Figure 10 is a Merck & Company file photo of the Rahway plant installation.